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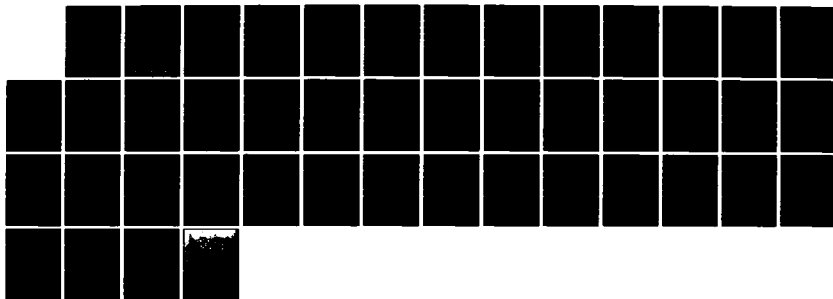
OCTANE REQUIREMENT INCREASE OF 1988 MODEL CARS(U)
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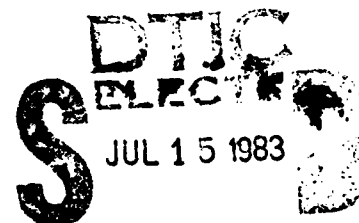
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OCTANE REQUIREMENT INCREASE OF 1980 MODEL CARS

June 1983

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**COORDINATING RESEARCH COUNCIL, INC.
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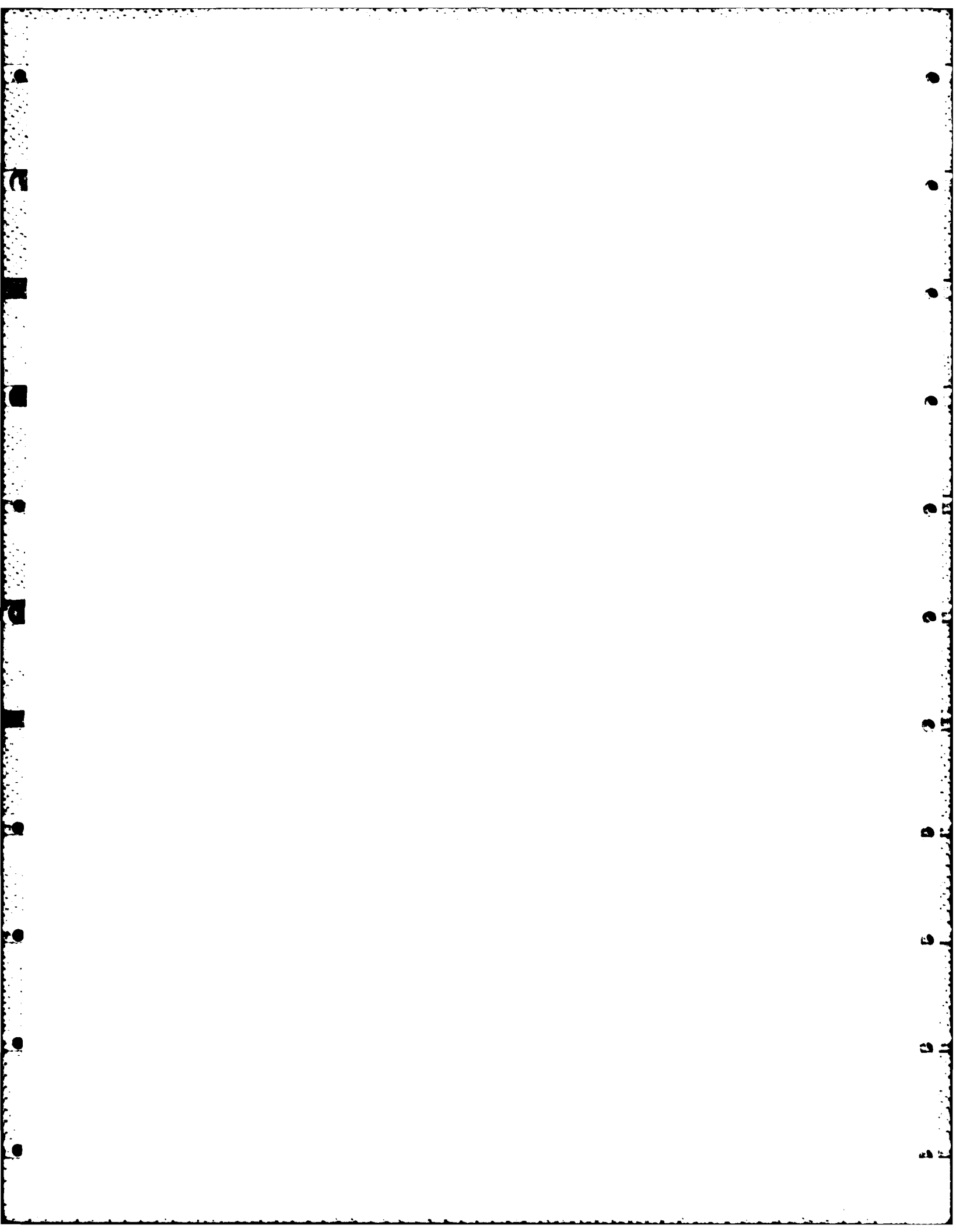


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I. SUMMARY

- Octane requirement increase (ORI) was determined for 120 1980 model cars operated on unleaded gasoline. All ORI values were determined from the increase in maximum octane requirements irrespective of whether requirements were obtained at full- or part-throttle.
- At 15,000 miles, the mean ORI for all cars with full boiling range unleaded (FBRU) fuels was 5.1 Research octane numbers, 3.5 Motor octane numbers, and 4.3 (R+M)/2 numbers.
- At 15,000 miles, the mean ORI for 89 cars with full boiling range high sensitivity unleaded (FBRSU) fuels was 5.0 Research octane numbers, 3.3 Motor octane numbers, and 4.1 (R+M)/2 numbers.
- At 15,000 miles, the mean ORI for all cars with primary reference fuels (PRF) was 3.9 octane numbers.
- Compared with 1979 models (109 cars), the mean ORI for all cars in the 1980 program with FBRU fuels was 0.3 RON lower and 0.1 MON lower. Neither difference is statistically significant.
- In general, the mean ORI with FBRU fuels has not changed appreciably from the 1975 through 1980 model cars.
- ORI decreases about 0.3 octane number per octane number increase of initial octane requirements; this relationship is statistically significant. ←

II. INTRODUCTION

The need to study octane requirement increase (ORI) with unleaded fuel became evident in 1970 when manufacturers announced that cars would require catalytic converters and use unleaded gasoline of at least 91 RON quality to meet future emission standards. Since that time, manufacturers have made many engine modifications to meet both exhaust emission and fuel economy standards. Because of these engine design changes and the increasing use of unleaded gasoline, the Coordinating Research Council, Inc. (CRC) initiated a series of ORI programs in 1971.

The ORI data from 1971 and 1973 through 1979 model cars have been reported previously.⁽¹⁻⁷⁾ This report will summarize ORI data for 1980 model cars.

III. EXPERIMENTAL

A. Cars Tested

In the 1980 program, 117 US and three imported cars were used to determine the ORI of 1980 model cars. Cars tested were not selected to represent the distribution of vehicles produced in that model year; rather the data base consists of information volunteered by participants. Data on cars that did not complete 15,000 miles of testing were excluded from the analyses. Participating laboratories are listed in Appendix A.

B. Mileage Accumulation

Mileage accumulation was conducted from the fall of 1979 through the fall of 1981. All test cars were operated in customer-type service using unleaded fuels typical of commercially available gasoline. No attempt was made to separate the data so that fuel-to-fuel or laboratory-to-laboratory effects could be determined.

C. Unleaded Average Sensitivity Full-Boiling Range Reference Fuels (FBRU)

In general, octane number requirements of 1980 model cars were defined initially with 1979 FBRU fuels. As mileage increased, the reference fuels were replaced with the 1980 FBRU fuels. One laboratory (Laboratory A) used a third FBRU reference fuel series for all octane requirements it submitted. The RON-to-MON conversions used in the data analysis for 1980 cars are shown in Appendix C, Table C-1.

D. High Sensitivity Unleaded Full-Boiling
Range Reference Fuels (FBRSU)

Octane requirements of 89 cars were defined initially with 1979 FBRSU fuels and later with 1980 FBRSU fuels as well as with FBRU and Primary Reference (PR) fuels. The RON-to-MON conversions used in the data analysis are shown in Appendix C, Table C-II.

E. Primary Reference (PR) Fuels

Standard ASTM PR fuels were used in two octane number increments from 76 to 82, and in one octane number increments from 82 to 100, to cover the range of car requirements.

F. Test Technique

Octane number requirements were determined at incremental mileages from zero to 15,000 miles by the 1980 CRC E-15 technique. Maximum octane number requirements were determined with both FBRU and PR fuels on 120 cars. Maximum requirements on 89 cars were also determined using FBRSU fuels.

IV. DISCUSSION OF RESULTS

A. Data Analysis Technique

For this program, octane requirements were to be obtained at 0, 5,000, 10,000, and 15,000 miles; however, not all the data were obtained exactly at these mileage intervals. To compare the ORI of all cars at the same mileage, results were determined from best-fit curves of actual reported octane requirements. Research octane number requirements (RONR) reported by the participants were plotted at the mileages at which they were obtained. Requirements at 0, 5,000, 10,000, and 15,000 miles were then read from best-fit curves as shown in Figure 1. ORI at 5,000, 10,000, and 15,000 miles were determined from these best-fit-curve requirements.

ORI on a Motor octane number (MON) basis was determined from best-fit-curve RON requirements that were translated into MON requirements according to the RON-to-MON conversions in Tables C-I and C-II. Similarly, ORI on an $(R+M)/2$ basis was determined from $(R+M)/2$ requirements that were calculated from best-fit-curve RON and corresponding MON values. Requirements of 1980 cars were initially determined on 1979 reference fuels and later on 1980 fuels. The

appropriate RON-to-MON conversion was determined by the fuel series used to determine the actual reported requirement that was closest to the 0-, 5,000-, 10,000-, or 15,000-mile interval. Laboratory A used a third FBRU reference fuel series; all data reported by this laboratory were translated according to the Laboratory A RON-to-MON conversion in Table C-I.

Best-fit-curve octane requirements at 0, 5,000, 10,000, and 15,000 miles are listed for each car in Appendix D, Tables D-I and D-II. Copies of raw octane requirement data and best-fit curves are on file with CRC.

Distribution of initial RON, MON, and $(R+M)/2$ requirements, as well as ORI values for each mileage interval, are summarized in Tables I, II, and III for FBRU, FBRSU, and PR fuels, respectively.

Distributions of initial RON requirements are plotted in Figure 2 for all three fuel series. Distributions of ORI at various mileages for RON, MON, and $(R+M)/2$ on FBRU fuels are shown in Figures 3, 4, and 5, respectively, and on FBRSU fuels in Figures 6, 7, and 8. Similarly, distribution of ORI on PR fuels at various mileages are shown in Figure 9.

Thirty-six cars had octane requirements determined beyond 20,000 miles. Of these, only five cars showed that their requirements had increased more than one RON between 15,000 and 20,000 miles. For over 80 percent of the cars, requirements appear to have stopped increasing with mileage.

Because of logistics problems, full-boiling reference fuels from two different years had to be used in the development of the best-fit-curve requirements. As can be seen in Tables C-I and C-II of Appendix C, at a given Research octane number, the corresponding Motor octane number difference varies from 0.3 to 1.4 numbers for FBRU, and from -0.9 to 0.4 numbers for FBRSU fuels from 1979 to 1980. These changes can cause the ORI determined using two years' fuels to be different from one obtained using the same fuel throughout the test. It is possible that these changes in Motor octane number on the average could have resulted in overestimating the ORI for 1980 model cars by as much as 0.5 number for FBRU fuel, and 0.2 number for FBRSU fuel.

Members of the Analysis Panel are listed in Appendix B.

B. Comparison of 1975 through 1980 ORI Studies

The mean ORI values for 1975 through 1980 model cars are:

Model Year	Accumulated Miles	Mean ORI	
		FBRU, RON	PRF
1975	16,000	5.8	4.4
1976	15,000	5.4	3.6
1977	15,000	4.9	2.9
1978	15,000	6.0	4.2
1979	15,000	5.4	4.1
1980	15,000	5.1	3.9
1975-1980 Unweighted Average:		5.4	3.7

Except for the 1977 PR fuel data, the mean ORI value has not changed appreciably from 1975 to 1980.

C. ORI Versus Initial Octane Requirements

Initial RON requirements are plotted against ORI at 15,000 miles in Figures 10, 11, and 12 for FBRU, FBRSU, and PR fuels, respectively. The correlation between initial requirements and ORI was determined by linear least squares regression analysis. The general form of the equation was:

$$\text{ORI} = a + b (\text{Initial Octane Requirement})$$

The best-fit lines are also shown in Figures 10, 11, and 12.

Equations for the three reference fuel series are:

Reference Fuel Series	a		b		R
	Estimate	Value of Estimate	Estimate	Value of Estimate	
FBRU	23.5	4.3	-0.21	3.4	0.09
FBRSU	32.3	5.8	-0.31	5.0	0.22
PR	32.7	8.3	-0.33	7.4	0.31

In general, ORI decreases about 0.2 to 0.3 units per unit increase of initial requirements. Although the correlation coefficients (R^2) are small, the analysis indicates that the estimates of the slope (ORI/Initial Requirement) are statistically significant. This phenomenon has not been observed and reported in previous CRC studies, and may be an anomaly of the data.

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CITED REFERENCES

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T A B L E S
AND
F I G U R E S

TABLE I

INITIAL OCTANE NUMBER REQUIREMENTS AND ORI AT VARIOUS MILEAGES -- FBRI FUELS

Group	No. Cars	RON						MON						(R+M)/2					
		5,000-Mi.		10,000-Mi.		15,000-Mi.		5,000-Mi.		10,000-Mi.		15,000-Mi.		5,000-Mi.		10,000-Mi.		15,000-Mi.	
		Initial Requirement	ORI	Initial Requirement	ORI	Initial Requirement	ORI	Initial Requirement	ORI	Initial Requirement	ORI	Initial Requirement	ORI	Initial Requirement	ORI	Initial Requirement	ORI	Initial Requirement	ORI
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
All Cars	120	87.8	3.7	3.1	1.9	4.4	2.3	5.1	2.6	80.6	2.3	2.0	1.3	2.9	1.7	3.5	2.0	84.2	3.0
All Make A	28	88.6	2.3	3.2	1.6	4.2	1.9	4.6	2.1	80.9	1.3	1.8	0.9	2.5	1.2	3.0	1.4	84.7	1.8
All Make B	13	87.0	5.2	2.6	1.8	3.7	2.0	4.4	1.8	80.0	3.2	1.7	1.2	2.5	1.6	3.1	1.6	83.5	4.2
All Make C	74	87.8	3.7	3.2	2.0	4.7	2.5	5.5	2.9	80.7	2.4	2.2	1.4	3.2	1.9	3.8	2.2	84.3	3.0
All Others	5	85.5	5.3	1.9	1.2	2.7	1.9	3.3	2.0	79.0	3.2	1.4	1.1	1.9	1.6	2.3	1.6	82.2	4.3
Engine A23	6	88.2	2.6	2.3	2.1	3.0	2.6	3.4	2.6	80.7	1.4	1.4	1.3	1.8	1.8	2.3	1.8	84.5	2.0
Engine A42	8	87.6	2.3	3.9	1.6	4.9	1.9	5.2	1.9	80.3	1.3	2.2	0.9	2.8	1.1	3.2	1.3	84.0	1.8
Engine A50	11	89.0	2.2	3.0	1.3	4.1	1.5	4.6	1.9	81.1	1.2	1.8	0.8	2.5	0.9	2.8	1.2	85.0	1.7
Engine B17	4	80.8	2.8	4.0	1.8	5.0	2.0	5.0	1.9	79.1	2.1	2.7	1.2	3.8	1.6	3.9	1.6	81.9	2.4
Engine B52	7	89.0	1.6	2.0	1.6	3.1	2.0	4.0	2.0	81.1	0.9	1.2	1.0	1.9	1.4	2.6	1.7	85.1	1.2
Engine C16	5	85.1	5.1	3.1	2.1	4.5	2.4	5.3	2.4	78.8	3.2	1.9	1.3	3.1	1.2	3.6	1.3	81.9	4.2
Engine C25	6	86.8	2.9	2.7	2.1	4.0	1.8	5.1	2.1	80.1	1.9	1.8	1.0	2.8	1.1	3.4	1.6	83.5	2.4
Engine C28	6	79.5	1.8	4.1	1.5	5.9	2.2	6.7	2.3	75.2	1.2	3.0	1.3	4.2	1.8	4.8	1.8	77.4	1.5
Engine C388	4	93.0	0.9	1.1	1.3	1.8	1.4	2.2	1.5	83.5	0.6	0.8	0.9	1.2	1.0	1.9	1.4	88.2	0.8
Engine C38C	9	89.6	1.6	1.4	0.7	2.6	1.2	3.6	2.0	81.9	1.2	0.8	0.4	1.6	0.9	2.5	1.4	85.8	1.4
Engine C41	10	87.3	1.9	5.7	1.9	7.9	2.6	9.0	3.0	80.4	1.1	4.0	1.3	5.6	1.9	6.5	2.3	83.9	1.5
Engine C43	6	87.9	1.3	3.3	1.1	4.4	1.7	4.9	2.3	81.0	0.9	2.3	0.8	3.1	1.2	3.5	1.7	84.5	1.1
Engine C44	12	88.4	2.3	2.5	1.4	3.6	1.9	4.0	2.0	80.8	1.4	1.4	0.8	2.7	1.1	2.4	1.1	84.6	1.9
Engine C50	15	90.2	1.2	3.8	1.8	5.3	2.1	6.2	2.9	82.3	0.7	2.7	1.3	3.8	1.6	4.6	2.1	86.3	0.9

TABLE II

INITIAL OCTANE NUMBER REQUIREMENTS AND ORI AT VARIOUS MILEAGES -- FBRSU FUELS

Group	No. Cars	RON						MON						(R+M)/2											
		5,000-Mi.			10,000-Mi.			5,000-Mi.			10,000-Mi.			5,000-Mi.			10,000-Mi.			5,000-Mi.			10,000-Mi.		
		Initial Requirement	ORI	Mean	SD	Mean	SD	Initial Requirement	ORI	Mean	SD	Mean	SD	Initial Requirement	ORI	Mean	SD	Mean	SD	Initial Requirement	ORI	Mean	SD	Mean	SD
All Cars	89	88.1	4.2	3.1	2.0	4.4	2.6	5.0	2.7	79.3	2.7	2.0	1.4	2.9	1.8	3.3	1.9	83.7	3.4	2.5	1.7	3.6	2.2	4.1	2.3
All Make A	27	88.9	2.4	3.4	1.6	4.5	2.0	5.0	2.2	79.8	1.5	2.1	1.0	2.9	1.3	3.1	1.4	84.4	1.9	2.7	1.3	3.7	1.6	4.0	1.8
All Make B	11	87.2	5.1	2.5	2.2	3.4	2.7	4.1	2.5	78.8	3.4	1.7	1.5	2.3	1.9	2.8	1.7	83.0	4.2	2.1	1.9	2.9	2.3	3.4	2.1
All Make C	46	88.0	4.6	3.2	2.2	4.6	2.9	5.4	3.1	79.2	3.0	2.1	1.5	3.1	2.0	3.6	2.2	83.6	3.8	2.7	1.8	3.9	2.4	4.5	2.6
All Others	5	86.6	5.6	1.7	1.0	3.2	2.0	4.0	2.4	78.2	3.7	1.2	0.8	2.1	1.3	2.7	1.5	82.4	4.6	1.4	0.9	2.7	1.6	3.3	2.0
Engine A23	6	89.3	2.5	2.3	1.1	3.0	1.7	3.3	2.0	80.1	1.6	1.5	0.7	1.9	1.1	2.1	1.2	84.8	2.0	1.9	0.9	2.4	1.4	2.7	1.6
Engine A42	8	87.9	2.4	4.2	1.1	5.4	1.9	5.8	1.9	79.2	1.5	2.6	1.0	3.4	1.2	3.6	1.2	83.5	1.9	3.4	1.3	4.4	1.6	4.7	1.6
Engine A50	10	88.8	2.4	3.4	1.6	4.5	2.1	4.9	2.3	79.8	1.5	2.1	1.1	2.9	1.4	3.1	1.5	84.3	2.0	2.8	1.4	3.7	1.7	4.0	1.9
Engine B17	4	82.0	2.2	4.5	1.9	6.0	2.3	6.3	2.6	75.4	1.7	3.1	1.4	4.2	1.8	4.4	1.9	78.7	2.0	3.8	1.6	5.1	2.0	5.3	2.2
Engine B52	5	89.4	2.0	1.3	1.3	1.9	1.8	2.7	1.6	80.2	1.3	0.8	0.8	1.2	1.2	1.6	0.9	84.8	1.7	1.0	1.1	1.6	1.5	2.2	1.3
Engine C16	5	85.8	5.4	3.7	1.1	4.9	1.4	5.5	1.9	77.8	3.6	2.4	0.8	3.2	0.9	3.6	1.3	81.8	4.5	3.0	1.0	4.1	1.2	4.6	1.6
Engine C25	6	87.4	3.3	3.0	2.4	4.9	2.9	6.2	2.9	78.9	2.2	2.0	1.5	3.1	1.8	3.9	1.8	83.2	2.8	2.5	2.0	4.0	2.4	5.1	2.4
Engine C28	6	80.8	2.6	4.0	2.3	5.8	3.1	6.6	3.0	74.4	1.8	2.8	1.7	4.0	2.2	4.5	2.0	77.6	2.2	3.4	2.0	4.9	2.6	5.6	2.5
Engine C38B	4	94.6	0.4	1.3	1.2	1.8	1.4	1.8	1.5	83.4	0.4	0.9	0.9	1.3	1.1	1.2	1.2	89.0	0.4	1.1	1.0	1.5	1.3	1.5	1.3
Engine C38C	5	90.1	1.8	1.4	0.6	2.6	1.1	3.7	2.2	80.6	1.1	0.9	0.4	1.6	0.7	2.3	1.4	85.4	1.4	1.1	0.5	2.1	0.9	3.0	1.8
Engine C44	12	88.7	2.8	2.6	1.4	3.7	2.0	4.2	2.2	79.7	1.8	1.6	0.9	2.4	1.2	2.6	1.4	84.2	2.3	2.1	1.2	3.1	1.6	3.4	1.8
Engine C50	5	90.2	3.7	4.7	2.3	6.2	2.7	6.7	2.7	80.6	2.4	3.2	1.5	4.3	1.8	4.6	1.9	85.4	3.0	4.0	1.9	5.2	2.2	5.6	2.3

TABLE III

INITIAL OCTANE NUMBER REQUIREMENTS AND ORI AT VARIOUS MILEAGES -- PR FUELS

Group	No. Represented 120-Car Group	Initial Requirements (120 Cars)		5,000-Mile ORI (120 Cars)		10,000-Mile ORI (120 Cars)		15,000-Mile ORI (120 Cars)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
All Cars	120	86.3	3.6	2.5	1.6	3.4	2.0	3.9	2.1
All Make A	28	87.4	2.5	2.7	1.7	3.5	2.1	3.8	2.3
All Make B	13	85.1	4.9	2.6	1.9	3.6	2.3	4.0	2.1
All Make C	74	86.2	3.5	2.5	1.5	3.5	1.9	4.0	2.1
All Others	5	83.9	4.8	1.2	1.1	1.9	1.5	2.5	1.8
Engine A23	6	87.1	3.0	2.2	1.4	2.8	1.7	3.0	1.9
Engine A42	8	87.0	2.1	3.1	1.6	4.0	1.7	4.4	1.6
Engine A50	11	87.6	2.8	2.8	2.1	3.6	2.6	3.9	2.9
Engine B17	4	78.9	3.4	4.2	2.4	5.3	2.7	5.4	2.6
Engine B52	7	87.4	1.4	1.8	1.4	2.6	2.0	3.2	1.9
Engine C16	5	82.5	4.4	2.4	1.4	3.5	2.0	3.8	2.2
Engine C25	6	85.0	2.1	2.8	1.8	3.9	1.6	4.6	1.5
Engine C28	6	79.0	1.6	3.6	2.0	5.2	2.9	5.9	3.3
Engine C38B	4	90.9	1.8	0.8	1.2	1.1	1.4	1.4	1.3
Engine C38C	9	88.8	1.7	1.2	0.7	2.0	0.8	2.9	1.4
Engine C41	10	85.1	1.4	3.3	1.5	4.5	2.0	5.1	2.3
Engine C43	6	85.8	1.2	3.3	1.3	4.2	1.8	4.0	2.0
Engine C44	12	87.1	1.6	2.3	1.1	3.2	1.5	3.6	1.7
Engine C50	15	88.3	1.4	2.5	1.1	3.3	1.5	3.6	1.7

FIGURE 1
BEST-FIT-CURVE ORI ANALYSIS

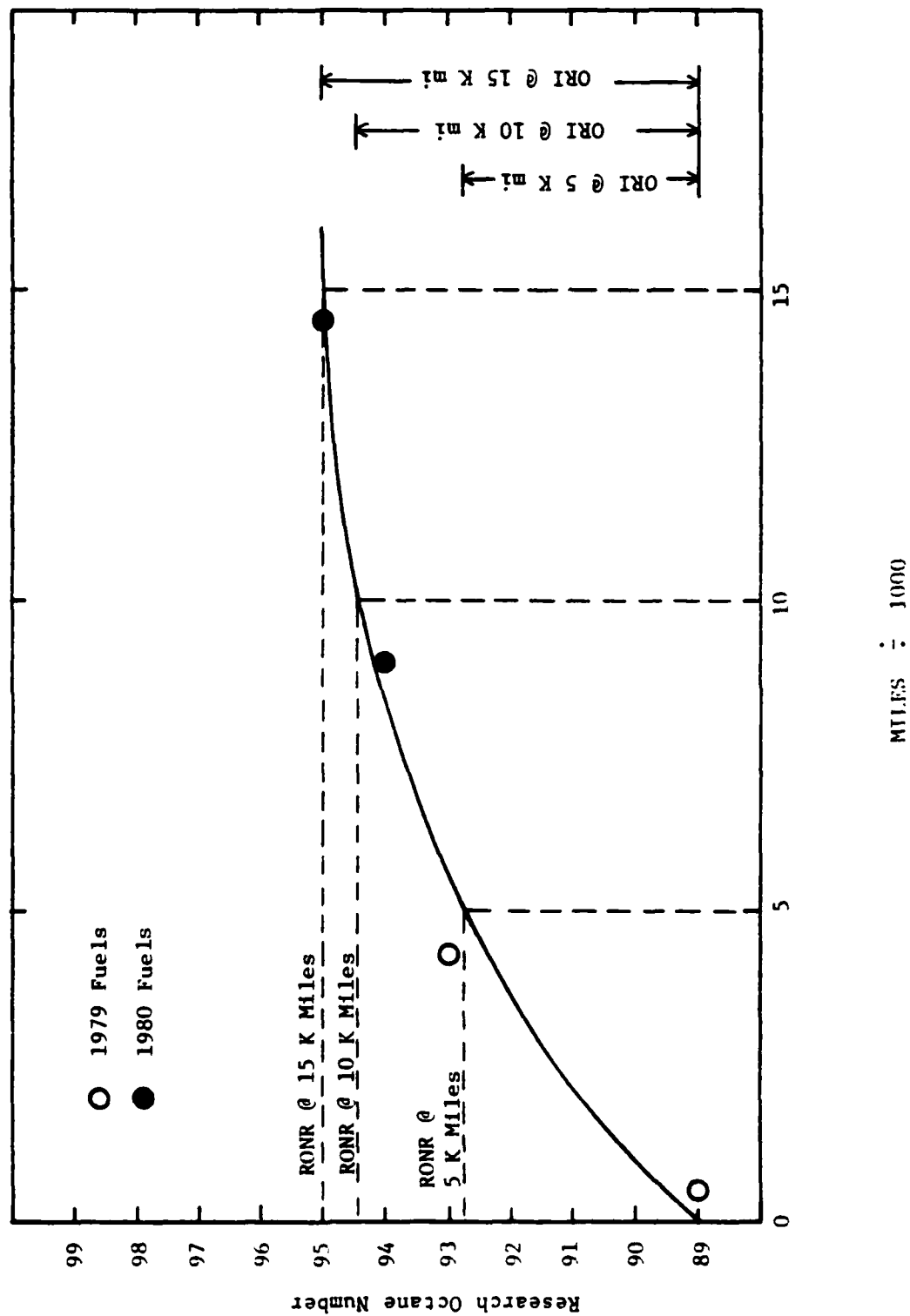


FIGURE 2
DISTRIBUTION OF INITIAL RON REQUIREMENTS
FOR 1980 MODEL CARS

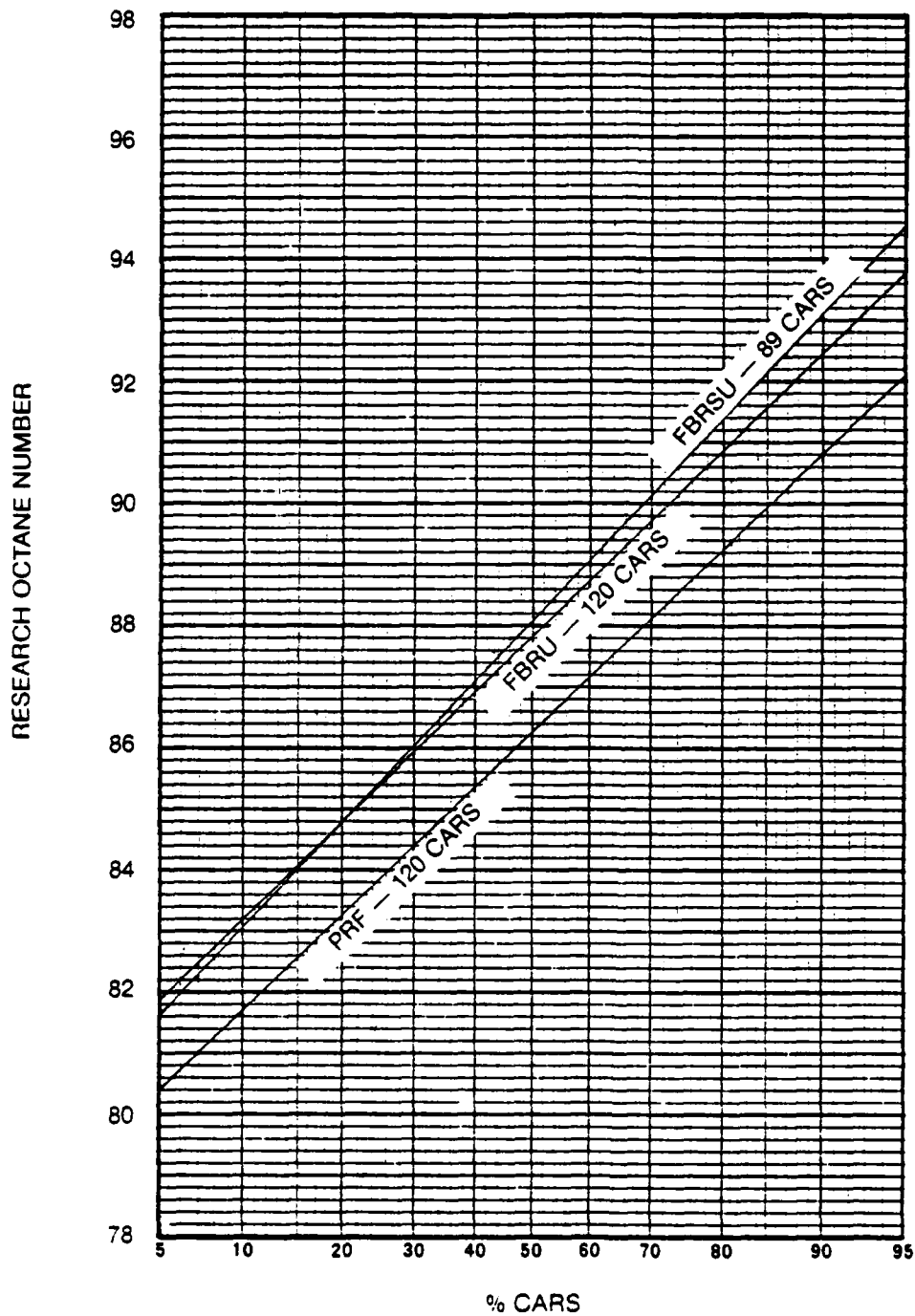


FIGURE 3
DISTRIBUTION OF RON ORI FOR
120 1980 MODEL CARS AT
VARIOUS MILEAGES ON FBRU FUELS

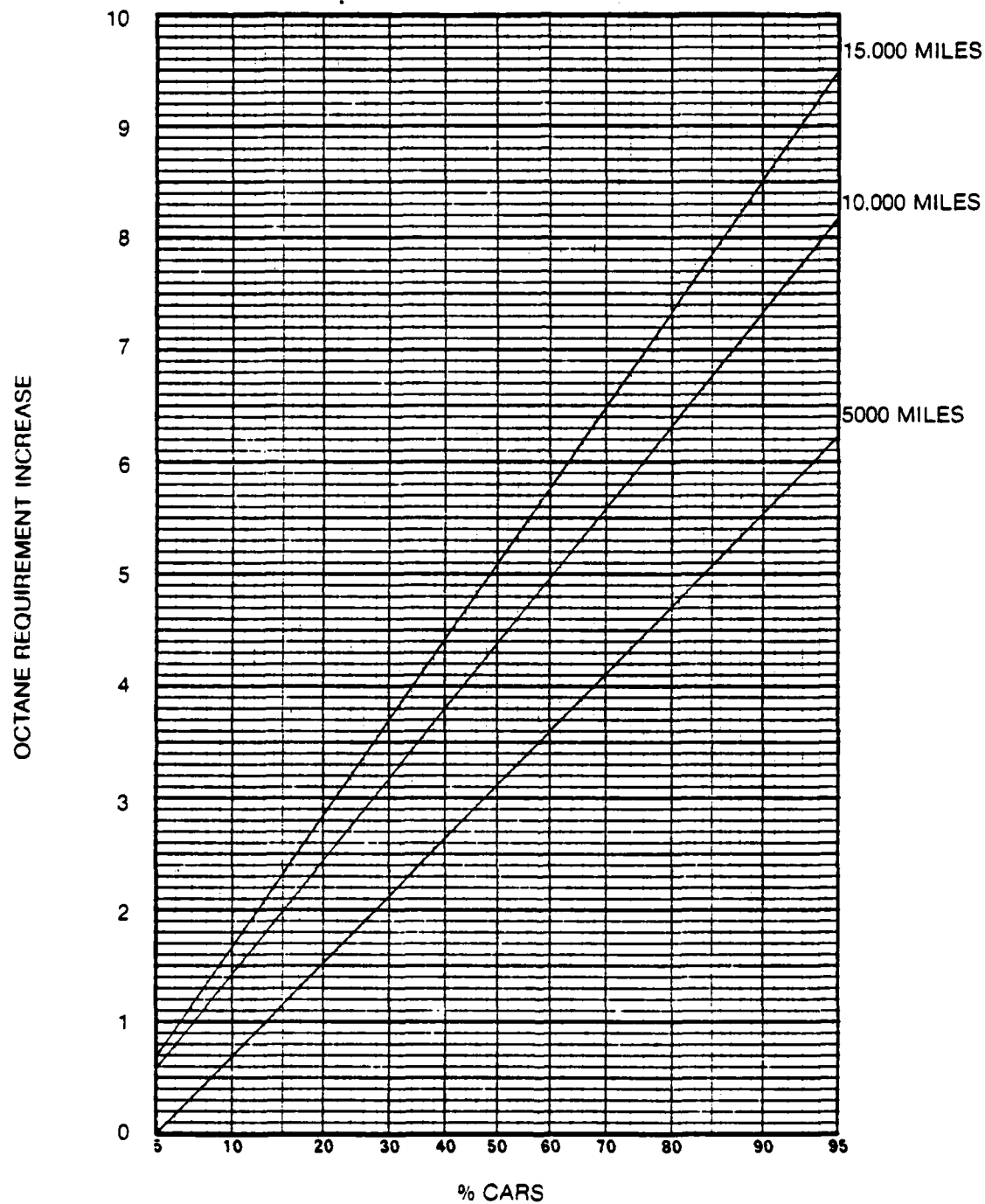


FIGURE 4
DISTRIBUTION OF MON ORI FOR
120 1980 MODEL CARS AT
VARIOUS MILEAGES ON FBRU FUELS

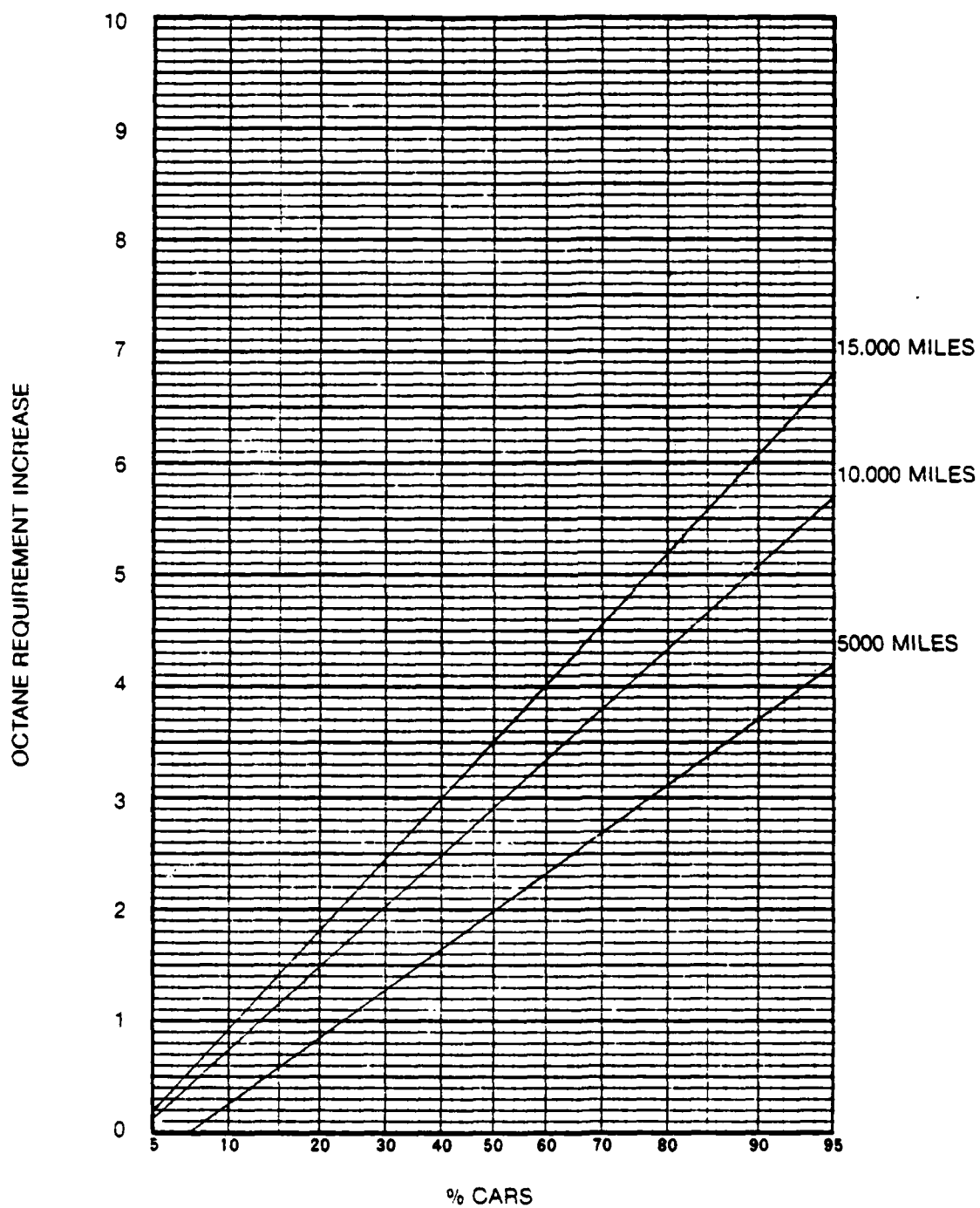


FIGURE 5
DISTRIBUTION OF (R+M)/2 ORI FOR
120 1980 MODEL CARS AT
VARIOUS MILEAGES ON FBRU FUELS

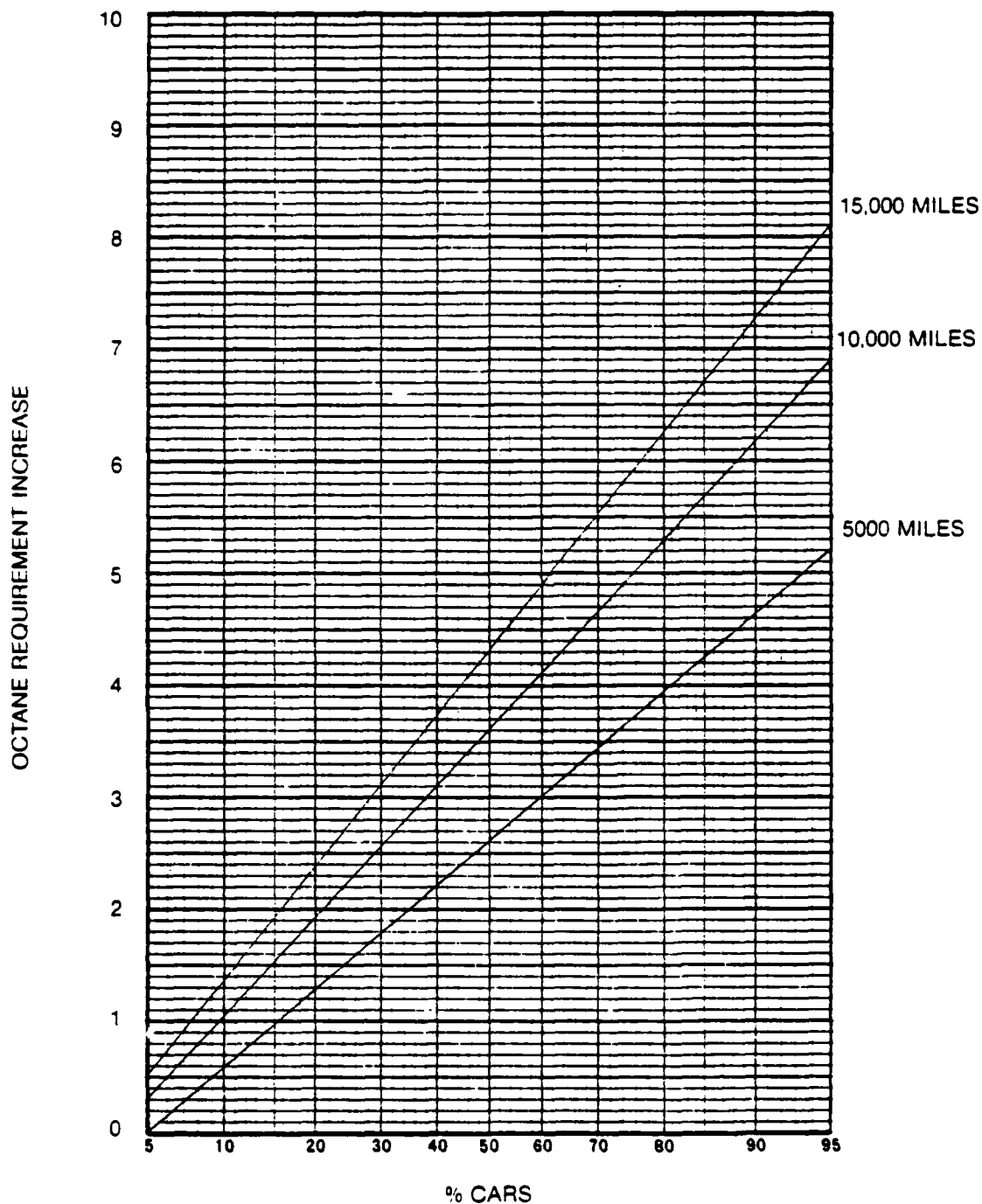


FIGURE 6

DISTRIBUTION OF RON ORI FOR
89 1980 MODEL CARS AT
VARIOUS MILEAGES ON FBRSU FUELS

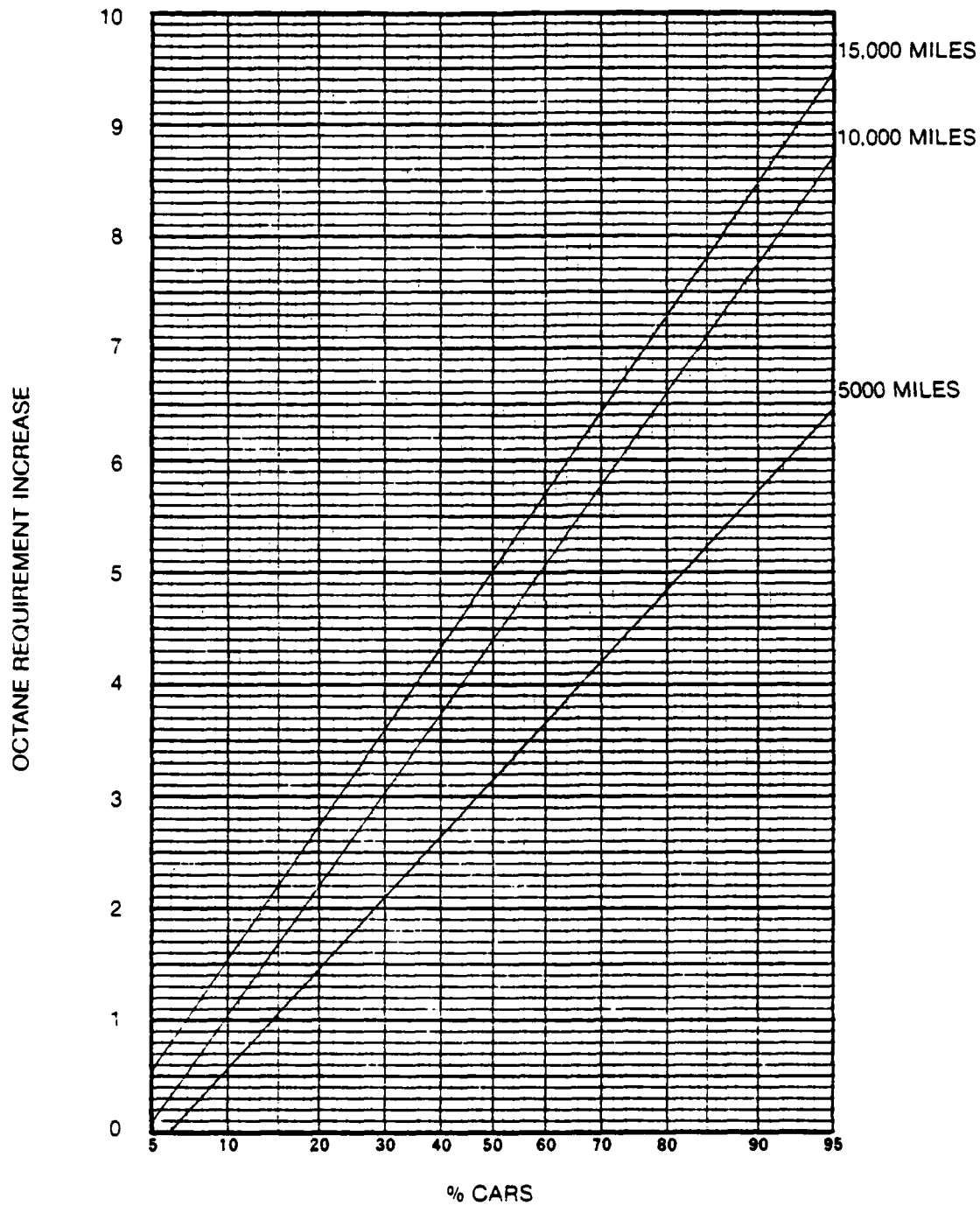


FIGURE 7
DISTRIBUTION OF MON ORI FOR
89 1980 MODEL CARS AT
VARIOUS MILEAGES ON FBRSU FUELS

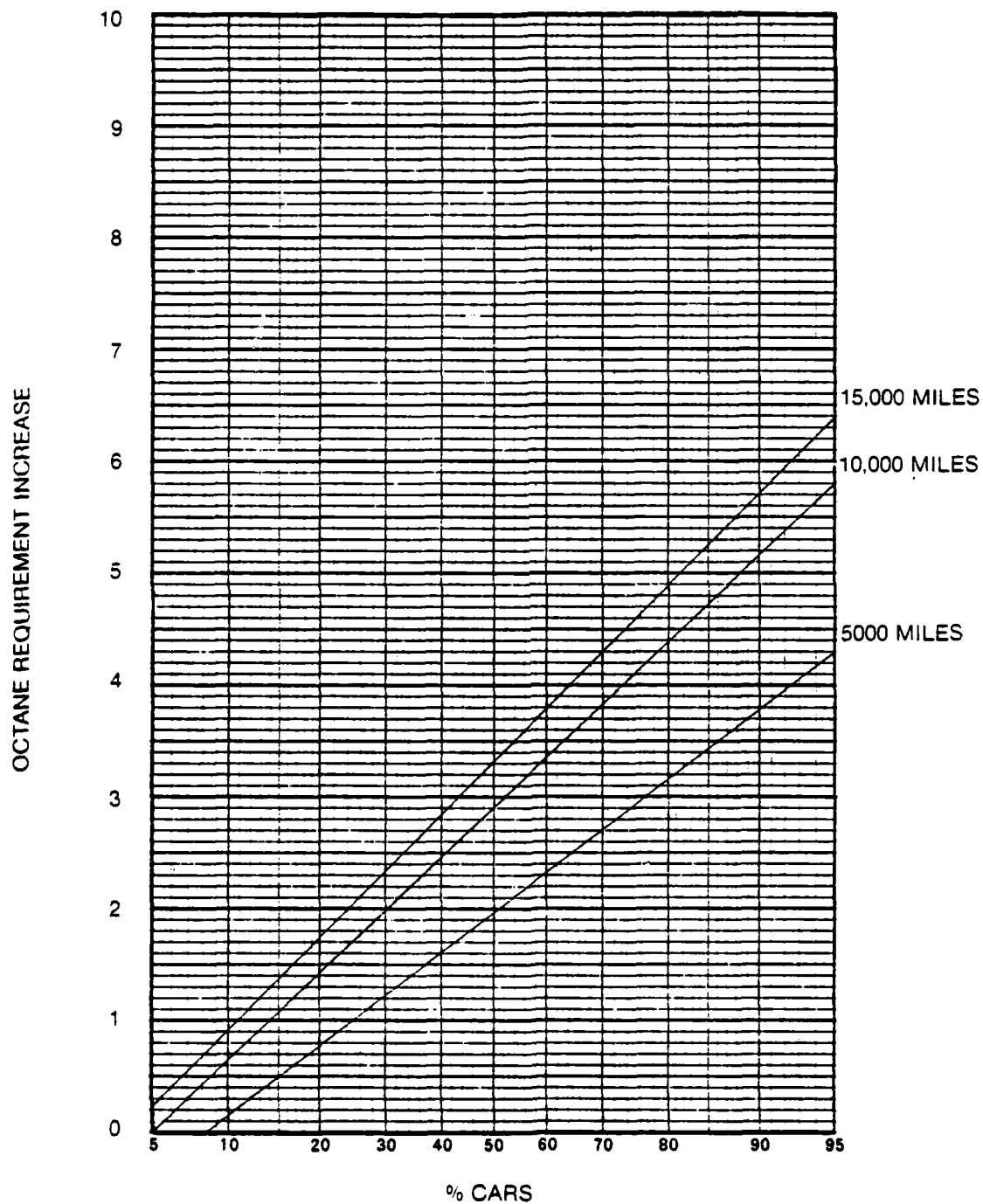


FIGURE 8
DISTRIBUTION OF (R+M)/2 ORI FOR
89 1980 MODEL CARS AT
VARIOUS MILEAGES ON FBRSU FUELS

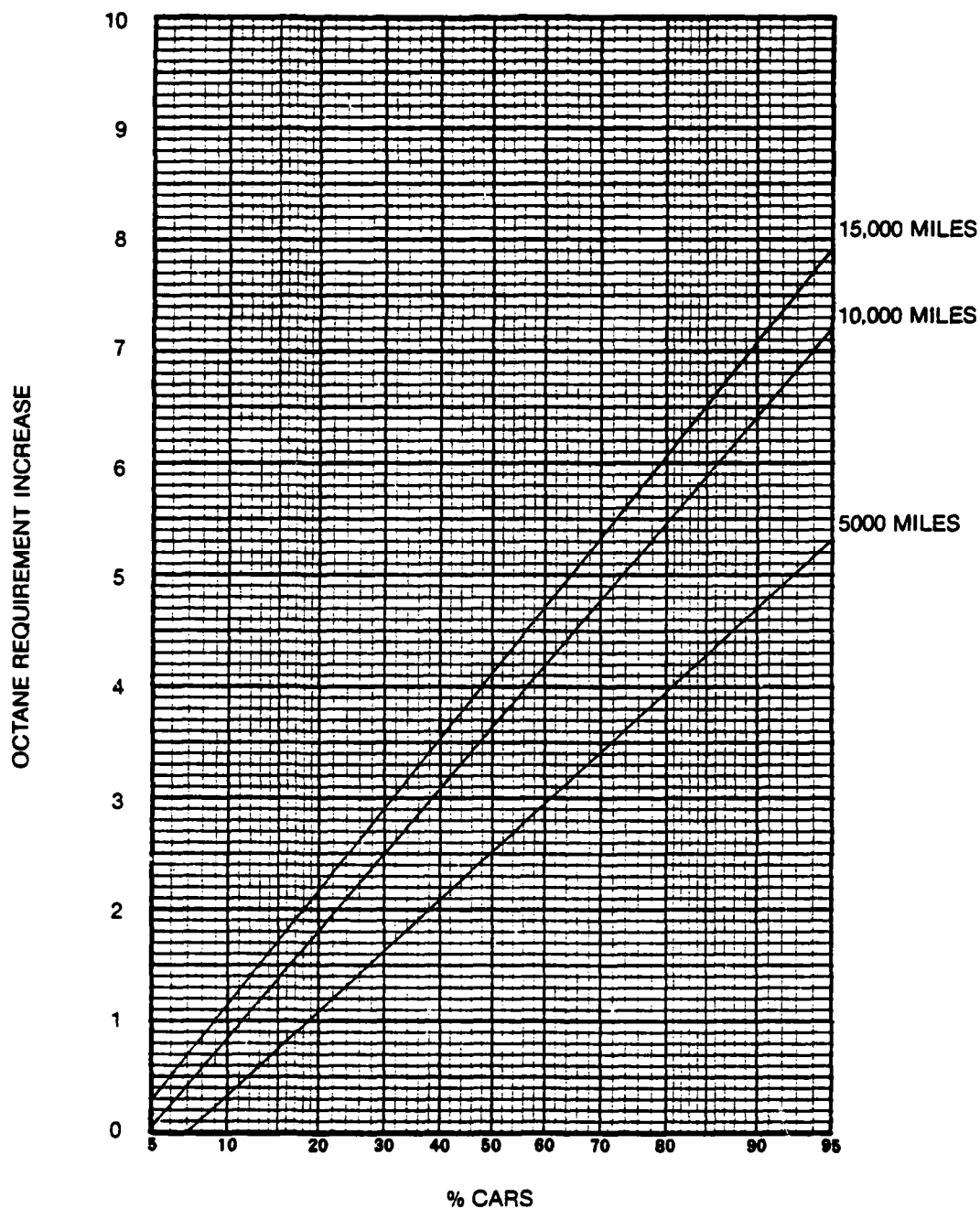


FIGURE 9
DISTRIBUTION OF ORI FOR
120 1980 MODEL CARS AT
VARIOUS MILEAGES ON PR FUELS

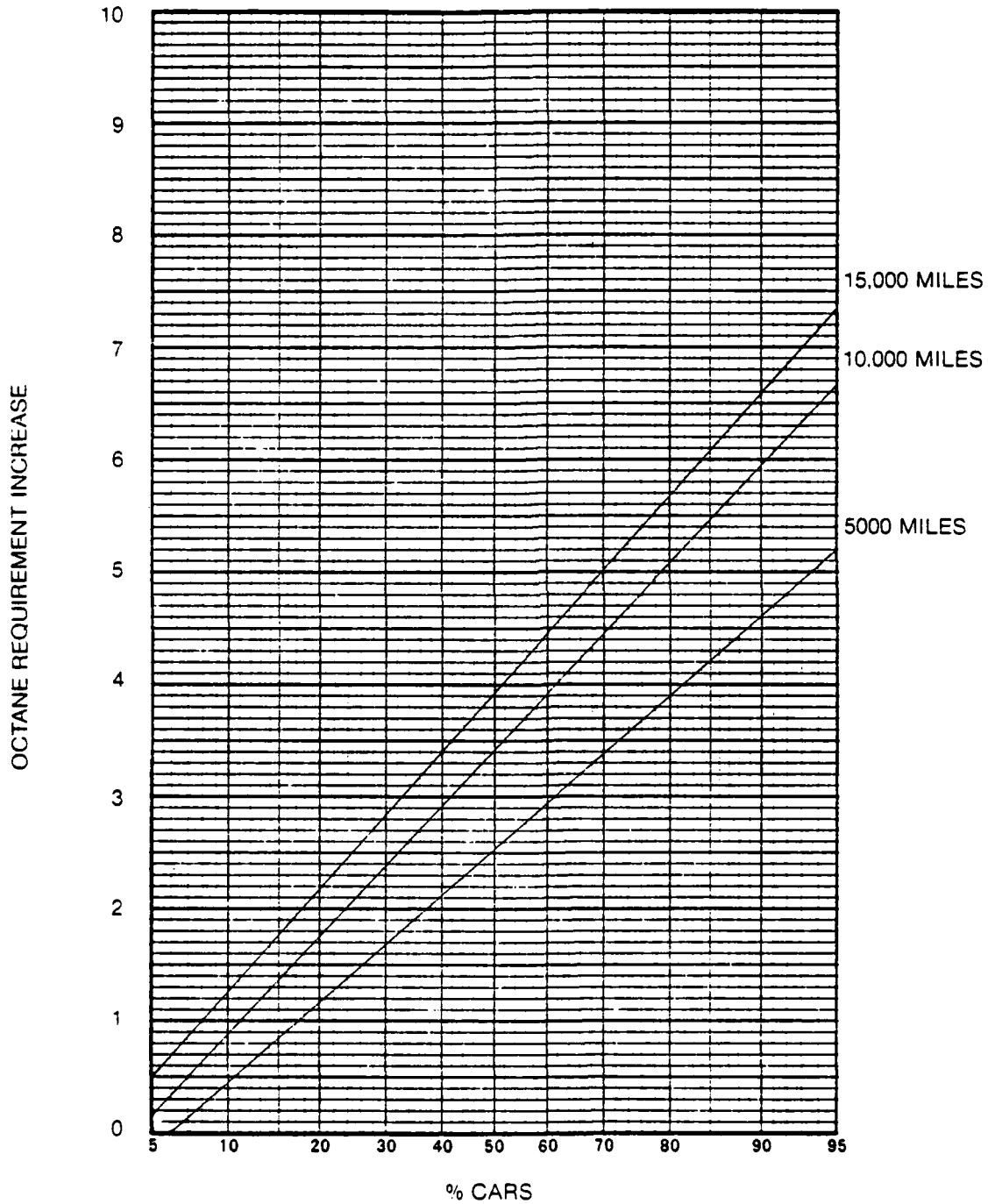


FIGURE 10

OCTANE REQUIREMENT INCREASE
AT 15,000 MILES
FBRU

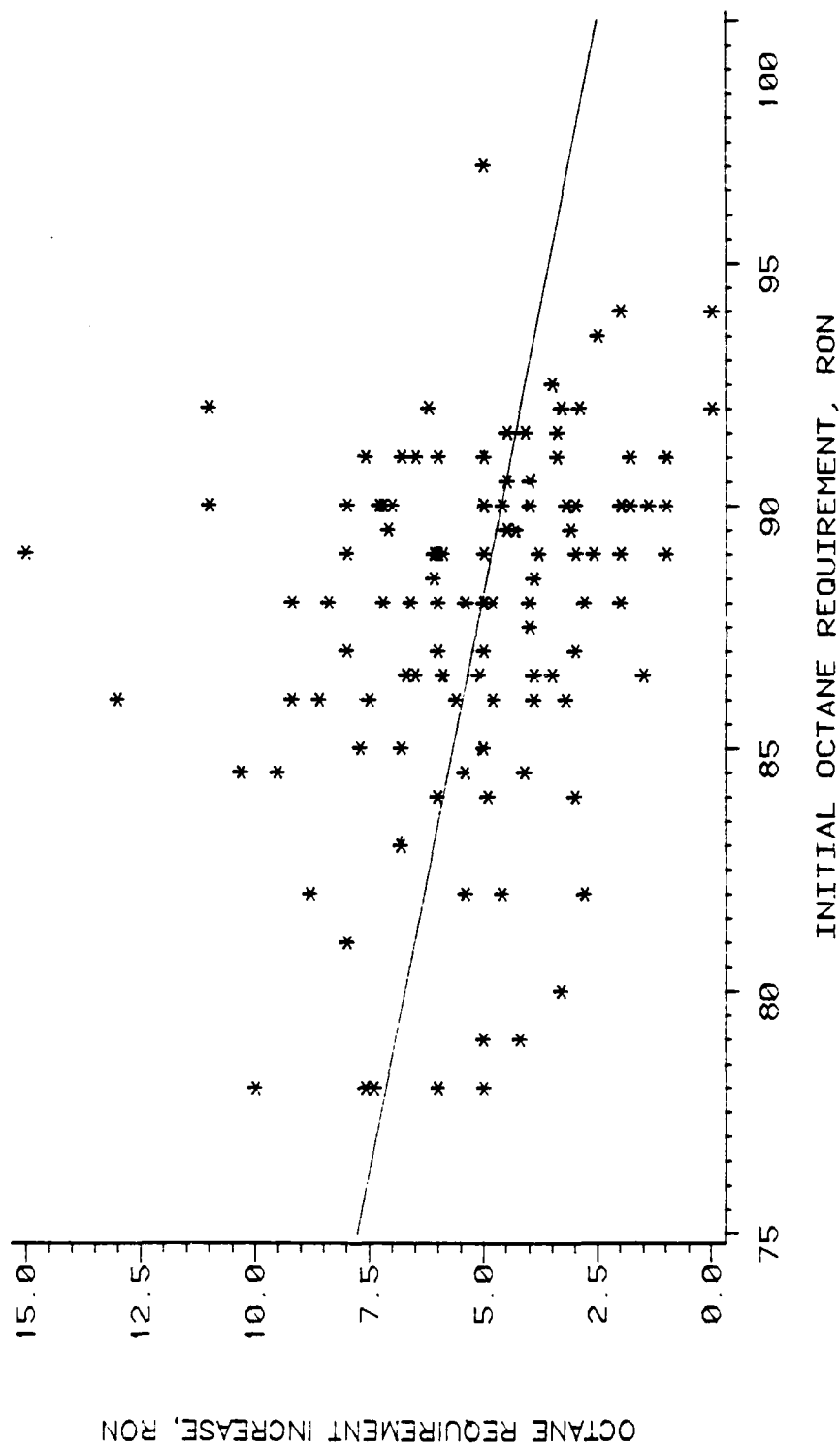


FIGURE 11

**OCTANE REQUIREMENT INCREASE
AT 15,000 MILES
FBR SU**

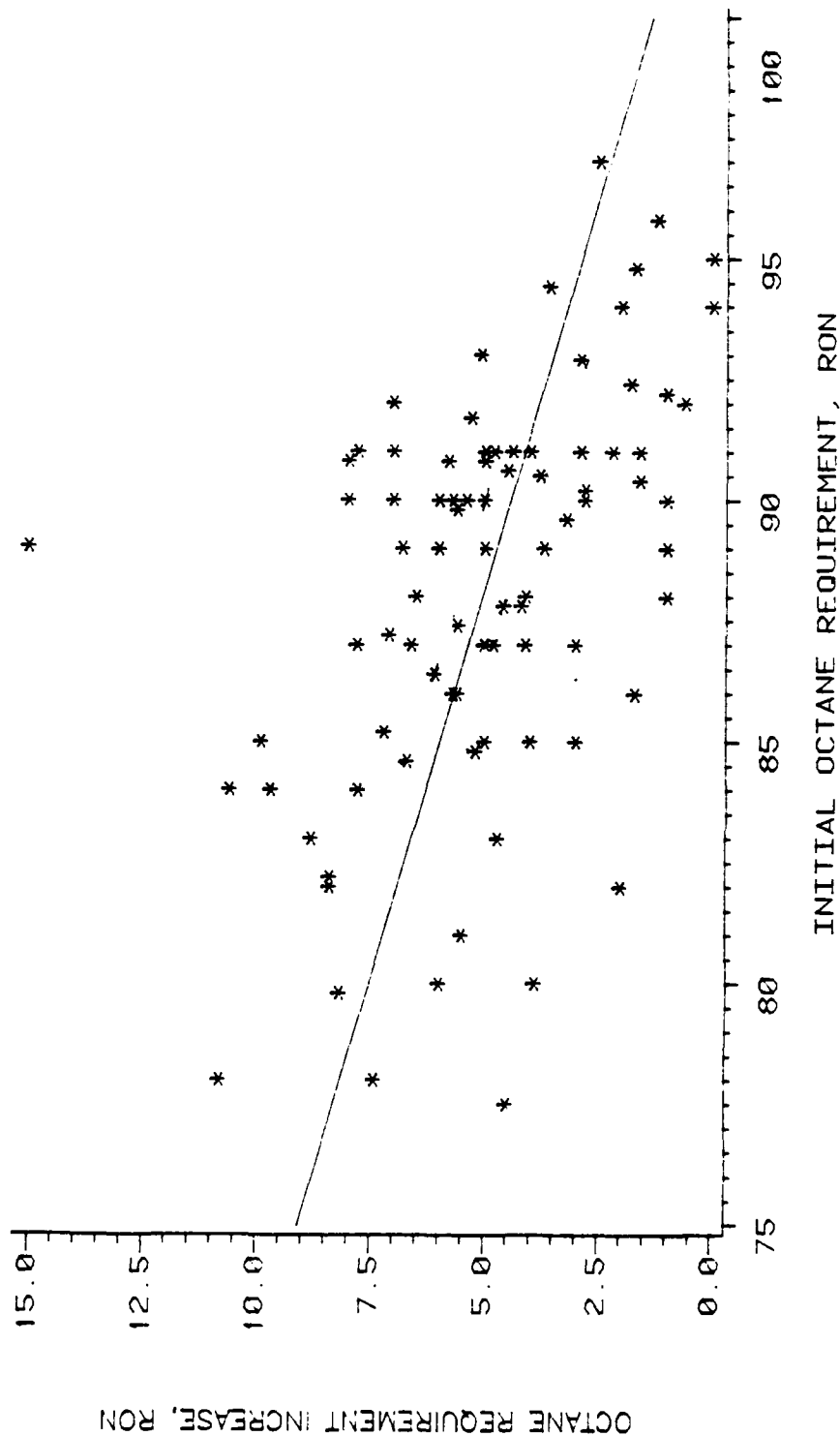
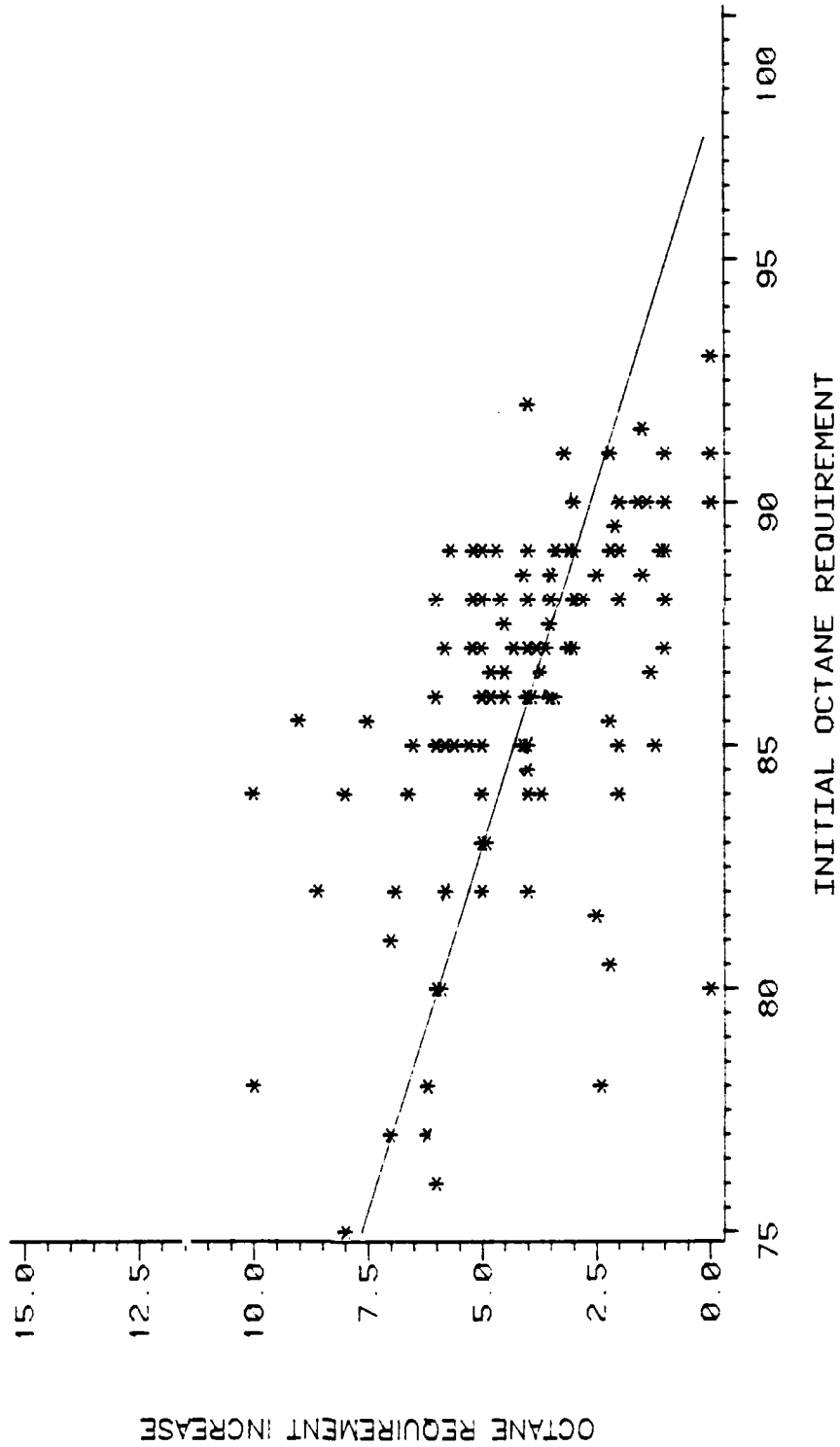


FIGURE 12

OCTANE REQUIREMENT INCREASE
AT 15,000 MILES
PRF



A P P E N D I X A

LABORATORIES REPORTING OCTANE REQUIREMENT
DATA AT VARIOUS MILEAGES

LABORATORIES REPORTING OCTANE REQUIREMENT
DATA AT VARIOUS MILEAGES

Amoco Oil Company
Naperville, Illinois

General Motors Research Laboratories
Warren, Michigan

Gulf Research and Development Company
Pittsburgh, Pennsylvania

Phillips Petroleum Company
Bartlesville, Oklahoma

Shell Development Company
Houston, Texas

Standard Oil Company (Ohio)
Cleveland, Ohio

Union Oil Company of California
Brea, California

A P P E N D I X B

MEMBERSHIP:

1980 OCTANE REQUIREMENT INCREASE
DATA ANALYSIS PANEL

1980 OCTANE REQUIREMENT INCREASEDATA ANALYSIS PANEL

<u>Name</u>	<u>Company</u>
J. B. Smith, Leader	Amoco Oil Company
J. B. Baker	Shell Development Company
T. Wusz	Union Oil Company of California

A P P E N D I X C

REFERENCE FUEL DATA

TABLE C-IAVERAGE SENSITIVITY FULL-BOILING RANGE
UNLEADED REFERENCE FUEL SERIES

(FBRU)

<u>Research</u> <u>Octane No.</u>	<u>1979 Motor</u> <u>Octane No.</u>	<u>1980 Motor</u> <u>Octane No.</u>	<u>Lab A Motor</u> <u>Octane No.</u>
78.0	74.2	74.5	73.2
80.0	75.6	75.9	74.9
82.0	77.0	77.5	76.6
84.0	78.3	78.9	78.2
85.0	78.8	79.7	79.0
86.0	79.6	80.4	79.7
87.0	80.0	81.0	80.4
88.0	80.6	81.7	81.1
89.0	81.1	82.3	81.8
90.0	81.7	83.0	82.5
91.0	82.2	83.6	83.2
92.0	82.8	84.2	83.9
93.0	83.4	84.8	84.6
94.0	84.2	85.5	85.4
95.0	84.8	86.1	86.2
96.0	85.6	86.7	87.1
97.0	86.4	87.3	87.8
98.0	87.1	88.1	88.5
99.0	88.0	88.8	89.3
100.0	88.8	89.6	90.1
101.0	89.6	90.3	90.8

TABLE C-IIHIGH SENSITIVITY FULL-BOILING RANGE
UNLEADED REFERENCE FUEL SERIES

(FBRSU)

<u>Research Octane No.</u>	<u>1979 Motor Octane No.</u>	<u>1980 Motor Octane No.</u>
77.5	72.2	72.1
78.0	72.6	72.5
80.0	73.7	74.1
82.0	75.2	75.6
84.0	76.6	77.0
85.0	77.4	77.7
86.0	78.0	78.4
87.0	78.6	79.0
88.0	79.3	79.6
89.0	80.0	80.1
90.0	80.5	80.6
91.0	81.2	81.2
92.0	81.8	81.8
93.0	82.4	82.4
94.0	83.0	83.0
95.0	83.8	83.5
96.0	84.4	84.1
97.0	85.3	84.7
98.0	86.1	85.4
99.0	87.1	86.3
100.0	88.0	87.3
101.0	88.8	87.9

A P P E N D I X D

OCTANE REQUIREMENT DATA

TABLE D-I

OCTANE REQUIREMENTS FROM BEST-FIT CURVES -- FBRU & PR FUELS

(120 Cars)

Car Code	RON Requirements @ 000's Miles							
	FBRU Fuels				PR Fuels			
	0	5	10	15	0	5	10	15
IY450	90.0	96.3	97.0	97.0	88.5	91.4	92.0	92.0
IY450	90.0	93.2	94.0	94.0	89.0	91.0	91.0	91.0
IY450	88.0	92.2	93.6	94.0	87.0	90.2	91.6	92.2
IY450	89.5	92.2	92.6	92.6	89.0	90.8	91.2	91.2
IY450	88.0	91.8	94.8	97.2	87.0	90.0	91.0	91.3
IY450	90.0	96.6	98.8	101.0	88.0	91.4	92.6	93.2
IY450	92.0	96.7	98.0	98.2	87.0	90.2	91.6	92.2
L4441	88.0	93.8	94.9	95.2	86.0	88.8	89.8	90.0
L4441	86.0	90.8	93.1	94.6	82.0	85.6	87.1	87.8
L4441	86.0	92.8	96.4	99.0	84.0	89.8	92.2	94.0
L4441	84.5	90.4	93.1	94.8	84.0	86.3	87.3	87.7
L4441	86.0	92.3	93.5	93.5	85.5	87.5	87.8	87.7
L4441	88.5	93.6	94.6	94.6	86.0	89.3	89.9	89.9
L4441	86.0	90.1	92.8	95.2	85.0	87.4	89.4	90.8
HS243	88.5	91.7	92.4	92.4	84.0	88.8	90.2	90.6
HS243	90.0	92.9	94.0	94.6	86.5	90.3	91.2	91.3
HS243	86.5	91.3	92.7	93.2	85.0	89.2	90.4	91.0
HS243	86.5	89.8	90.4	90.4	85.0	88.2	88.9	89.0
HS243	88.0	92.2	94.6	96.4	87.0	90.0	91.0	91.0
HS243	88.0	89.6	89.9	90.0	87.0	88.0	88.0	88.0
NIK238	90.0	90.7	92.6	95.0	89.0	90.2	92.0	94.2
NIK238	91.0	91.9	92.0	92.0	90.0	91.7	92.0	92.0
NIK238	91.0	92.1	92.6	92.8	90.0	92.0	92.0	92.0
NIK238	90.0	92.4	94.9	97.2	91.0	91.1	92.1	94.2
IY450	90.0	92.2	93.0	93.2	90.0	91.3	91.6	91.6
L4441	88.0	91.8	93.7	94.6	87.0	88.3	89.4	90.6
NH450	90.0	92.0	92.0	92.0	90.0	90.8	91.0	91.0
MWV258	89.5	92.4	94.7	96.6	89.0	90.8	92.7	94.7
KI252	89.0	92.2	93.9	94.9	87.0	90.0	91.7	92.8
LIA238	92.0	93.5	94.3	94.9	90.0	90.6	90.9	91.0
NIJ244	94.0	95.8	96.0	96.0	90.0	91.0	91.4	91.4
OCA133	90.0	94.2	95.0	95.0	87.0	90.8	91.7	92.0
PL217	78.0	84.5	85.6	85.6	77.0	83.2	84.0	84.0
OCA242	88.0	91.0	92.4	93.4	88.0	90.2	91.0	91.5
NH450	91.5	92.8	93.8	94.9	90.0	91.7	92.0	92.0
NIK238	90.0	91.4	92.0	92.0	89.0	90.2	90.8	91.0
OCA223	89.0	89.4	90.4	92.0	86.0	88.2	89.8	90.8
NC7228	82.0	85.2	86.6	87.4	80.0	83.6	85.0	86.0
NL9216	88.0	89.0	89.8	90.8	84.0	85.7	86.0	86.0
T222	85.0	88.4	90.0	90.0	84.0	86.8	88.2	89.0

TABLE D-I
(Continued)

Car Code	RON Requirements @ 000's Miles							
	FBRU Fuels				PR Fuels			
	0	5	10	15	0	5	10	15
NC7228	78.0	82.0	84.0	85.4	78.0	81.0	82.8	84.2
NC7228	81.0	86.0	89.0	89.0	81.0	85.0	88.0	88.0
NC5225	87.0	89.0	91.0	93.0	85.0	87.4	89.7	90.6
NC5225	78.0	84.0	86.6	88.0	78.0	84.0	86.6	88.0
NC5225	86.5	86.8	89.5	93.0	86.0	86.0	87.4	89.4
PL217	82.0	85.2	86.2	86.6	81.5	82.8	83.6	84.0
PL217	84.0	86.5	87.0	87.0	82.0	85.2	86.0	86.0
PL217	79.0	82.8	84.0	84.0	75.0	81.0	83.0	83.0
IC5225	89.0	92.4	94.0	94.0	87.0	90.2	90.8	90.8
NIJ244	89.0	93.2	95.0	95.0	88.0	90.8	93.0	93.0
NIJ244	89.0	90.0	90.0	90.0	88.0	89.0	89.0	89.0
NIJ244	90.0	90.6	91.0	91.0	89.0	89.6	89.8	90.0
NIJ244	87.0	90.0	91.6	92.0	86.5	89.4	90.2	90.2
NIJ244	87.0	89.4	90.0	90.0	85.0	87.4	88.4	89.1
NIJ244	88.0	91.1	93.0	93.0	86.0	89.3	90.0	90.0
NIJ244	90.0	90.3	92.3	95.0	88.0	89.2	90.9	92.6
NIJ244	86.5	89.3	91.0	92.4	86.0	88.3	90.3	91.0
NIJ244	86.5	90.3	91.4	91.6	86.0	88.5	89.3	89.5
OI250	89.0	93.0	94.5	95.1	89.0	91.8	92.0	92.0
OI250	89.0	91.0	91.0	91.0	88.0	89.0	89.0	89.0
OI250	92.0	94.5	95.2	95.3	90.0	92.7	93.0	93.0
OCA242	89.5	94.0	94.0	94.0	89.0	92.0	92.4	92.4
OI250	91.0	93.0	94.4	94.4	90.0	91.4	92.6	93.0
OCA242	90.0	94.0	95.0	95.0	88.5	90.2	91.4	92.6
OCA242	86.0	91.0	91.6	91.6	86.0	90.2	90.8	90.8
OCA242	88.0	91.6	92.6	92.8	87.5	90.8	91.6	92.0
OI250	88.0	89.6	91.8	92.0	87.0	88.8	90.0	90.0
PC252	88.0	91.3	92.4	93.0	86.5	90.2	91.0	91.0
PC252	86.0	86.0	87.2	89.2	85.0	85.0	85.0	86.2
PC252	90.0	91.2	91.4	91.4	89.0	89.0	89.0	90.0
NC7228	80.0	81.8	82.6	83.3	80.0	80.0	80.0	80.0
NIK238	88.0	88.8	90.6	92.8	88.0	88.2	89.4	90.8
OWV258	91.5	94.4	96.0	96.0	91.0	91.9	92.0	92.0
NLV225	91.0	92.0	92.0	92.0	87.0	89.8	90.0	90.1
NL9216	78.0	79.6	81.4	83.0	76.0	79.4	81.2	82.0
OCA242	90.0	91.6	92.4	93.0	89.0	90.0	91.3	92.0
P252	90.0	90.0	90.8	91.8	88.0	89.0	89.8	90.0
LIA238	93.5	93.6	95.0	96.0	91.5	91.6	92.0	93.0
NL9216	91.0	95.0	96.8	97.5	86.5	87.0	87.4	87.8
NIK238	90.5	93.0	93.8	94.5	89.0	90.0	90.1	90.1

TABLE D-I
(Continued)

Car Code	RON Requirements @ 000's Miles							
	FBRU Fuels				PR Fuels			
	0	5	10	15	0	5	10	15
NH450	90.0	96.3	98.0	98.0	89.0	92.4	92.8	93.0
NTML457	84.0	86.0	88.0	90.0	82.0	84.0	85.7	87.0
OCA223	89.0	95.0	96.8	97.0	88.0	92.0	92.0	92.0
OTM250	87.0	92.8	94.4	95.0	86.0	91.0	91.8	92.0
OV250	91.0	94.6	95.5	96.0	91.0	92.4	93.0	93.2
IY450	91.0	95.8	97.6	98.6	88.0	90.4	92.4	94.0
PC137	97.0	98.5	99.8	102.0	92.0	94.0	96.0	96.0
P252	89.0	91.2	92.0	92.8	87.0	89.4	90.0	90.0
P252	91.0	95.0	97.0	97.8	89.0	91.2	93.0	94.0
NL9216	86.5	89.4	90.0	90.0	86.0	88.5	90.0	90.0
NL9216	82.0	88.2	90.0	90.8	80.0	84.0	85.3	85.9
LC5225	83.0	89.1	89.2	89.8	82.0	87.5	88.0	88.9
LC5225	84.5	88.0	89.3	89.9	83.0	86.2	87.4	88.0
LC7228	78.0	82.6	83.8	84.0	77.0	81.7	83.1	83.2
NIK238	90.0	91.4	91.9	92.0	88.5	90.2	90.8	91.0
NIK238	86.0	87.6	89.2	90.8	85.0	86.6	88.3	90.0
LIA238	94.0	94.0	94.0	94.0	93.0	93.0	93.0	93.0
IIA238	92.5	95.3	95.9	96.0	89.0	91.6	92.1	92.1
L4441	91.0	95.2	96.6	97.0	86.0	89.1	90.2	90.5
L4441*	89.0	99.2	103.0	104.0	85.5	91.5	92.9	93.0
NIJ244	85.0	90.0	91.6	91.8	85.0	89.3	90.8	91.5
NIJ244	89.0	91.2	91.6	91.6	88.0	90.8	91.0	91.0
NH450	91.5	94.3	95.3	95.6	89.0	92.3	93.4	93.7
IY450	90.0	95.3	96.9	97.3	85.0	89.0	90.2	90.3
IY450*	92.0	93.4	97.7	103.0	88.5	89.0	89.5	90.0
OCAT223	91.0	91.8	92.0	92.0	91.0	91.0	91.0	91.0
OCAT223	90.0	91.9	92.0	92.0	89.5	91.4	91.6	91.6
OCAT223	84.0	87.4	88.5	88.9	83.0	86.3	87.6	87.9
OCAT223	86.5	88.0	88.0	88.0	85.0	87.0	87.0	87.0
OI242	84.5	87.5	88.4	88.6	84.0	86.8	87.8	88.0
MI242	84.5	91.3	93.6	94.0	84.0	90.3	91.8	92.0
OV250	90.0	92.0	92.8	93.0	90.0	90.0	90.0	90.0
OV250	90.5	93.4	94.6	95.0	85.5	91.9	93.7	94.5
OV250	85.0	89.4	89.7	92.7	82.0	87.8	89.7	90.6
SF50	86.0	88.2	89.3	89.9	84.5	87.2	88.2	88.5
PC137	87.5	90.3	91.2	91.5	87.5	89.9	90.8	91.0
RC242	92.0	92.8	92.0	92.0	90.0	90.0	90.0	90.0
RL242	89.5	90.8	92.2	93.8	87.0	88.2	89.1	90.0
BAF16	79.0	81.8	82.8	83.2	78.0	79.3	80.0	80.4
BAF16	82.0	83.0	83.9	84.8	80.5	81.0	81.8	82.7

* Requirements were estimated from best-fit-curve.

TABLE D-II

OCTANE REQUIREMENTS FROM BEST-FIT CURVES -- FBRSU & PR FUELS

(89 Cars)

Car Code	RON Requirements @ 000's Miles							
	FBRSU Fuels				PR Fuels			
	0	5	10	15	0	5	10	15
MWV258	90.8	92.9	95.8	98.8	89.0	90.8	92.7	94.7
KI252	90.8	93.9	95.2	95.8	87.0	90.0	91.7	92.8
LIA238	94.8	95.9	96.4	96.5	90.0	90.6	90.9	91.0
NIJ244	95.8	96.8	97.0	97.0	90.0	91.0	91.4	91.4
OCA133	90.8	95.2	96.2	96.6	87.0	90.8	91.7	92.0
PL217	79.8	86.8	88.0	88.0	77.0	83.2	84.0	84.0
OCA242	89.8	93.1	94.6	95.4	88.0	90.2	91.0	91.5
NH450	92.9	94.2	95.0	95.8	90.0	91.7	92.0	92.0
NIK238	92.4	93.3	93.7	94.2	89.0	90.2	90.8	91.0
OCA223	90.6	93.2	94.4	95.1	86.0	88.2	89.8	90.8
NC7228	84.8	87.4	88.8	90.0	80.0	83.6	85.0	86.0
NL9216	89.6	92.5	92.8	92.8	84.0	85.7	86.0	86.0
T222	86.0	88.5	91.5	91.7	84.0	86.8	88.2	89.0
NC7228	78.0	81.9	83.9	85.4	78.0	81.0	82.8	84.2
NC7228	82.0	86.9	90.2	90.4	81.0	85.0	88.0	88.0
NC5225	88.0	90.5	93.0	94.5	85.0	87.4	89.7	90.6
NC5225	78.0	85.4	87.8	88.8	78.0	84.0	86.6	88.0
NC5225	87.0	87.4	90.6	94.8	86.0	86.0	87.4	89.4
PL217	82.2	86.7	89.3	90.6	81.5	82.8	83.6	84.0
PL217	85.0	87.4	88.0	88.0	82.0	85.2	86.0	86.0
PL217	81.0	85.2	86.5	86.5	75.0	81.0	83.0	83.0
IC5225	90.0	94.4	96.7	97.0	87.0	90.2	90.8	90.8
NIJ244	89.0	93.2	95.0	95.0	88.0	91.8	93.0	93.0
NIJ244	89.0	89.9	90.0	90.0	88.0	89.0	89.0	89.0
NIJ244	90.0	91.2	92.1	92.8	89.0	89.6	89.8	90.0
NIJ244	87.0	90.0	91.4	91.8	86.5	89.4	90.2	90.2
NIJ244	87.0	89.4	89.9	90.0	85.0	87.4	88.4	89.1
NIJ244	87.4	90.4	92.7	93.0	86.0	89.3	90.0	90.0
NIJ244	90.0	91.3	93.5	96.0	88.0	89.2	90.9	92.6
NIJ244	87.0	90.2	91.6	92.0	86.0	88.3	90.3	91.0
NIJ244	86.4	90.4	91.8	92.5	86.0	88.5	89.3	89.5
OI250	89.0	93.0	94.4	95.0	89.0	91.8	92.0	92.0
OI250	89.0	90.0	90.0	90.0	88.0	89.0	89.0	89.0
OCA242	89.0	93.4	94.0	94.0	89.0	92.0	92.4	92.4
OI250	91.0	94.1	95.4	95.4	90.0	91.4	92.6	93.0
OCA242	90.0	93.6	94.7	95.0	88.5	90.2	91.4	92.6
OCA242	86.0	91.1	91.6	91.6	86.0	90.2	90.8	90.8
OCA242	87.2	91.8	93.5	94.3	87.5	90.8	91.6	92.0
OI250	87.8	90.4	91.8	92.0	87.0	88.8	90.0	90.0
PC252	86.0	86.0	86.2	87.7	85.0	85.0	85.0	86.2

TABLE D-II

(Continued)

Car Code	RON Requirements @ 000's Miles							
	FBRSU Fuels				PR Fuels			
	0	5	10	15	0	5	10	15
PC252	90.0	90.8	91.0	91.0	89.0	89.0	89.0	90.0
NC7228	82.0	82.5	83.0	84.0	80.0	80.0	80.0	80.0
NIK238	89.0	90.2	92.8	95.8	88.0	88.2	89.4	90.8
OWV258	91.7	94.9	96.9	97.0	91.0	91.9	92.0	92.0
NLV225	92.0	92.0	92.0	92.6	87.0	89.8	90.0	90.1
NL9216	77.5	81.5	82.0	82.0	76.0	79.4	81.2	82.0
OCA242	91.0	92.6	94.2	95.0	89.0	90.0	91.3	92.0
P252	91.0	91.2	91.7	93.2	88.0	89.0	89.8	90.0
LIA238	94.0	95.2	96.0	96.0	91.5	91.6	92.0	93.0
NL9216	91.0	93.4	96.0	98.0	86.5	87.0	87.4	87.8
NIK238	90.5	92.9	93.8	94.3	89.0	90.0	90.1	90.1
NH450	90.0	96.4	97.7	98.0	89.0	92.4	92.8	93.0
NTML457	84.0	89.0	92.7	94.6	82.0	84.0	85.7	87.0
OCA223	90.0	93.0	94.5	95.4	88.0	92.0	92.0	92.0
OTM250	87.0	92.0	93.4	93.6	86.0	91.0	91.8	92.0
OV250	91.0	95.3	96.0	96.0	91.0	92.4	93.0	93.2
PC137	97.0	97.0	97.6	99.5	92.0	94.0	96.0	96.0
P252	89.0	91.2	92.2	92.7	87.0	89.4	90.0	90.0
NL9216	87.0	91.0	92.0	92.0	86.0	88.5	90.0	90.0
NL9216	84.0	89.2	91.0	91.8	80.0	84.0	85.3	85.9
LC5225	83.0	89.0	91.2	91.8	82.0	87.5	88.0	88.9
LC5225	84.6	89.2	90.7	91.3	83.0	86.2	87.4	88.0
LC7228	80.0	84.5	85.8	86.0	77.0	81.7	83.1	83.2
NIK238	91.0	92.1	92.6	92.6	88.5	90.2	90.8	91.0
NIK238	87.8	89.3	90.8	92.4	85.0	86.6	88.3	90.0
LIA238	95.0	95.0	95.0	95.0	93.0	93.0	93.0	93.0
LIA238	94.4	97.2	97.9	98.0	89.0	91.6	92.1	92.1
L4441	92.0	96.1	98.5	99.0	86.0	89.1	90.2	90.5
L4441*	89.0	99.2	103.0	104.0	85.5	91.5	92.9	93.0
NIJ244	85.2	90.5	92.0	92.4	85.0	89.3	90.8	91.5
NIJ244	90.4	91.9	92.0	92.0	88.0	90.8	91.0	91.0
NH450	93.0	96.5	97.8	98.1	89.0	92.3	93.4	93.7
IY450	91.0	96.9	98.5	98.8	85.0	89.0	90.2	90.3
IY450	84.0	90.6	92.7	93.7	88.5	89.0	89.5	90.0
OCAT223	92.2	93.2	93.2	93.2	91.0	91.0	91.0	91.0
OCAT223	90.2	92.8	93.0	93.0	89.5	91.4	91.6	91.6
OCAT223	85.0	88.8	89.9	90.0	83.0	86.3	87.6	87.9
OCAT223	88.0	89.0	89.0	89.0	85.0	87.0	87.0	87.0
OI242	85.0	88.4	89.1	89.0	84.0	86.8	87.8	88.0
MI242	85.0	92.2	94.5	94.9	84.0	90.3	91.8	92.0

* Requirements were estimated from best-fit-curve.

TABLE D-II
(Continued)

<u>Car Code</u>	<u>RON Requirements @ 000's Miles</u>							
	<u>FBRSU Fuels</u>				<u>PR Fuels</u>			
	<u>0</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>0</u>	<u>5</u>	<u>10</u>	<u>15</u>
OV250	91.0	92.8	93.6	93.9	90.0	90.0	90.0	90.0
OV250	91.0	94.2	95.3	95.8	85.5	91.9	93.7	94.5
OV250	84.0	90.6	92.7	93.7	82.0	87.8	89.7	90.6
SF50	87.0	89.4	90.5	91.1	84.5	87.2	88.2	88.5
PC137	88.0	90.9	91.8	92.1	87.5	89.9	90.8	91.0
RC242	94.0	94.0	94.0	94.0	90.0	90.0	90.0	90.0
RL242	90.0	91.8	93.8	95.7	87.0	88.2	89.1	90.0
BAF16	80.0	82.5	83.5	83.9	78.0	79.3	80.0	80.4
BAF16	83.0	84.6	86.2	87.7	80.5	81.0	81.8	82.7

END

FILMED

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DTIC